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APRIL

# THE MGA BULLETIN

1948

No. 11

ORGAN OF THE MUSHROOM GROWERS' ASSOCIATION

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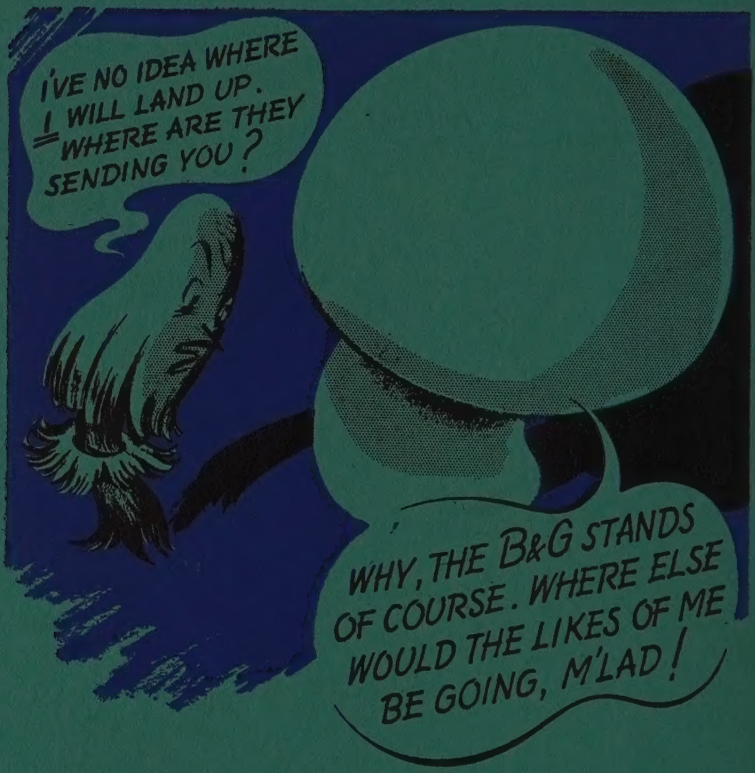
**PRICE 2/6**

THIS BULLETIN IS CONFIDENTIAL TO MEMBERS

COMMONWEALTH MYCOLOGICAL INSTITUTE 10 APR. 1948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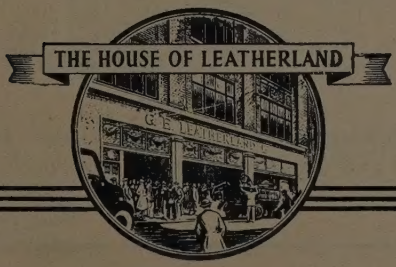

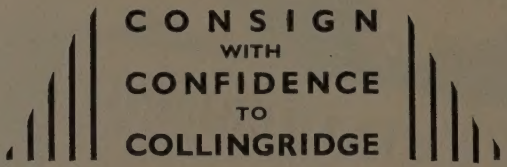


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# THE MUSHROOM GROWERS' ASSOCIATION

## NEW MEMBERS

*Since 31st DECEMBER, 1947*

★

| | |
|---|---|
| **BERKS.** | D. B. Neale, The Thatched Cottage, Elm Road, Reading.<br>M. A. Wright, Hazelhurst, Oxford Road, Tilehurst. |
| **GLOUCESTER.** | Major R. Mytton Mills, M.B.E., The Manor House, Meysey Hampton, Nr. Fairford. |
| **HERTS.** | S. G. Biss, 22 Eleanor Cross Road, Waltham Cross. |
| **KENT** | F. Allnutt, Palmsted Hill, Canterbury. |
| **LANCS.** | R. N. Tinniswood, 48 Market Street, West Houghton.<br>T. Orritt, 48 Orrell Lane, Burscough Bridge, Ormskirk. |
| **LINCS.** | Lady Chomeley, The Dower House, Easton, Grantham.<br>G. O. Stanland, Croftlands, Church Avenue, Humberston. |
| **SURREY** | E. C. Shaw, Courtlands, Shipley Bridge, Horley. |
| **SOMERSET** | M. Coombe, Southdown Nurseries, Bath. |
| **STAFFS.** | E. G. Hanwell, 11 Glebe Street, Stoke-on-Trent. |
| **SUSSEX** | S. A. F. Sampson, Rushmans Nursery, Oving, Nr. Chichester.<br>J. L. Kessler, Dingley Mushrooms, Rustington.<br>H. G. Andrews, Critchmere Nursery, Eastergate, Nr. Chichester.<br>H. L. Coulson, Bridge Nursery, Ham Road, Worthing.<br>A. G. Arnot, West Barnham Fruit Farm, W. Barnham.<br>A. G. Lindfield, Chesswood Nurseries, Thakeham.<br>Lt. W. N. Stone, Birch Cottage, Chiddingly, Nr. Lewes. |

### NEW HON. (OVERSEAS) MEMBER

B. O'Brien, Lynwood, Tramore, Co. Waterford, Eire.

### NEW HON. (ED. & ADV.) MEMBER

H. H. Glasscock, Wye College, Ashford, Kent.

### NEW HON. (ASSOCIATE) MEMBER

E. Sayner, Highfield, Brayton, Selby, Yorks.

### NEW HONORARY MEMBERS

| | |
|---|---|
| R. T. H. Gibbens | 25 West Glebe Road, Corby, Nr. Kettering. |
| T. W. Bartlett | Lake, Bradworthy, Devon. |
| B. Roberts | 17 Oddfellows Road, Morley, Leeds. |
| A. D. Kennedy | Milton Cottage, Laurieston, By Falkirk, Stirlingshire. |
| The Western Growers | 28 Pier Street, Aberystwyth. |
| T. K. Jenkins | 160 Hemdean Road, Caversham, Reading, Berks. |
| R. Gilchrist | Privick Nursery, Ayr, Scotland. |
| E. W. Newell | Kirkgate Market, Leeds. |
| E. I. Derbyshire | Lowersland, Mare Hill, Pulborough, Sussex. |

THE

APRIL 1948

# BULLETIN No. 11

*No responsibility can be assumed by the Editor, the Editorial Board, or the Mushroom Growers' Association, for statements made or views expressed in this Bulletin, or for any advertisements included in this publication.*

## EDITORIAL

This Association was formed during the latter war years, for a number of important reasons, not the least being the attitude of the Government towards the Mushroom Industry. Many growers will recall the policy of violent discrimination which was being levelled against growers. The truth of the matter is that the M.G.A. was formed more or less as a protective organisation, to try and do something about the attitude of officialdom, which was proving so disastrous to growers all over the country, and since that time the M.G.A. has always had this problem high on their agenda. The fight has been carried on through all channels and in all quarters.

Recently the Government policy has altered somewhat, ' relaxed ' is the official term used, and we have been assured by high-level Government spokesmen that there was no longer to be discrimination against mushroom growing and that it was to be placed on the same footing as any other horticultural crop. Despite these assurances this is not the case, and we still hear of cases where growers are met with opposition and obstruction. Whatever arguments are used, the mushroom is a food, and we are told that Britain needs all the food she can produce. In all fairness it must be said that this attitude against growers is not general, but the fact that it is displayed at all, indicates that there is a certain amount of confusion in the matter. One typical instance was mentioned at the Annual Meeting, where a member stood up and stated he had been refused a fuel allocation. Before he had sat down another member stood up and said he had received all the fuel he wanted—and they both come under the same A.E.C.! There can be no sensible reason why this should be the case. Either growers should be allowed to grow mushrooms, in which case they should be encouraged rather than discouraged, or they should be forthwith banned from growing. A policy which wavers somewhere between these two extremes has neither rhyme or reason behind it. It is high time that a definite Government policy towards all mushroom growers should be announced, and it is with this in mind that the M.G.A. has demanded such a state-

Editorial and Advertisement Office :
**MUSHROOM GROWERS' ASSOCIATION, YAXLEY, PETERBOROUGH**

ment. There is evidence that it will be forthcoming, and when it materialises members will receive a copy.

The British Medical profession have announced the fact that mushrooms contain folic acid, found also in liver and spinach, which is used for fighting pernicious anæmia. As this is of great importance to members as well as those suffering from this disease, the M.G.A. has asked an eminent dietician to go into the matter more fully and to write an article for the Bulletin. It is hoped it will be ready for the July issue and should prove of great interest. It may well have some influence on the Government attitude towards the Mushroom Industry providing the Medical profession still have any influence with the Government !

It is pleasing to be able to announce a further service to our members. In response to several enquiries, arrangements have now been made which will grant members the facility of insuring with the N.F.U. Mutual Insurance Society. This Company deals only with farmers' and growers' insurance and is limited to members of the N.F.U. and of course the M.G.A., and under these circumstances they can offer better rates than those of other companies. In some cases the saving is as high as 20% over normal insurance rates—quite a point in these days of economy.

Angus Watson.

The new Vice-Chairman of the M.G.A. is General Sir Oliver Leese, Bart., K.C.B., C.B.E., D.S.O., of Lower Hall, Worfield, Shropshire.

He is specifically responsible for the Association's intensive campaign for research and has attended numerous conferences in London recently where our problems in this field have been under discussion.

In a recent Chase publication, Sir Oliver advised growers that, "just as we used to make out carefully-prepared march tables for all our big moves in the Army during the War, so—if you are to have success—must you work out detailed cropping programmes quite twelve months ahead."

# MUTUAL AID

## Members Ask Your Advice

*Please send replies to the Editor, M.G.A. Bulletin*

Q. 73. All my mushroom beds are concrete and I propose to cover the concrete with Sisal Kraft or Union Kraft paper instead of doing this, do you recommend putting a layer (2 or 3 inches) of straw on the concrete or is this liable to cause the compost to dry up too much?

Q. 74. My new heavy watering method is producing the mushrooms, but after about 1½ lbs. per square foot I get patches of bacterial trouble. They start, these patches, by having one or maybe two mushrooms affected. Later in the same place four or five are touched. Then like dactylium another spot becomes affected, and so it goes on. The trouble is mainly on the top beds, though some areas are on the middle beds curiously enough, near the door ends—nearest the ventilation. I would suspect soil, or rather the inefficient sterilization of same, but since there is little or nothing to be seen on the bottom beds I cannot honestly do that. We are picking the affected mushrooms off as they appear, but that does not prevent the next flush being affected. Can you help me with my problem?

Q. 75. I usually need 4 trucks (approximately 30 tons) of fresh straw manure to fill 2,000 square feet of indoor beds. On my last crop the 4 truck loads weighing 29 tons 7 cwts., which should have been sufficient, in fact filled only 1,500 square feet, leaving my fourth bed bare. I think the manure, which received 5 turns during approximately 5 weeks, was over-composted and went in too short for my liking. Could composting a week too long account altogether for this 25% shrinkage?

Q. 76. We have great trouble and difficulty in getting sub-soil for casing the beds. It has occurred to us that it might be feasible to sterilize the old casing soil by heat and/or formalin and to use again. Do you think there is any objection to this?

Q. 77. We have a cultivation house made of bricks and asbestos-cement, lined inside with asbestos sheets. The size of the house is 106′ × 19′ × 11′ and it contains two ventilators about 10″ in diameter located about 35′ from each end. The house is heated by electric pipes and has five layers of beds. We have experienced some trouble regarding excess of moisture and are afraid of the accumulation of carbon dioxide. The moisture is condensing and dripping on the upper beds. Would you advise us, having in mind the construction of the house, of the additional ventilation necessary, or could it be adequately corrected by the occasional opening of doors. We are considering the use of calcium hydroxide (Ca (OH) ) or other chemicals for the removal of carbon dioxide. We have also been contemplating the use of fans. What do you advise?

Q. 78. The sale of capillary thermometers (new) at 25/-, carriage 1/6, complete with luminous dials, 10′ capillary tubes and reading 0 to 100° Centigrade has raised the query, " are these thermometers suitable for burying in the beds, with the dials at convenient points on the walls ? "

# Answers to Previous Questions

The purpose of this Mutual Aid Section is to provide an opportunity for members to seek the advice of their fellows. The success of the section depends entirely upon members themselves.

Q. 58. *Could you let us know the address of any suppliers of Oil Burning Units ?*

One firm is :—Hydran Products Ltd., Gresham Road, Staines, Middlesex, and the price is £250 to £300 for a 38K Ideal Sectional Boiler. The comparative price for a coal automatic stoker would be about £150-£180. R. FRYER.

Q. 66. *What demand is there for mushroom stalks ?*

Fortunately there is a very limited demand for mushroom stalks. All mushrooms marketed have a small portion of the growing stalk attached, or should have. Under good growing conditions the amount of stalk attached to the earth is negligible and may be attributed, when too long, to too high a temperature and insufficient ventilation. The question of marketing does not arise to a good grower ; if it did it would not be considered economical with present day labour costs and the high average price of mushrooms. C. P. CHAMBERLAIN.

Q. 67. *Have you any details regarding the control of long-legged mite ?*

Either (*a*) dust on a 1 lb. mixture of 6% Nicotine and Lime dust ; or (*b*) spray on a solution of 1 oz. Nicotine in 1 gall. water. Each control will treat about 80 square feet. Apply between flushes every 2 days, alternating spray with dust. If the soil is wet use dust only. W. A. B. HARDING.

Q. 68. *Instead of our beds cropping in the normal way they have been covered with pin-heads which have withered and died. Eventually the beds did crop in the normal way. What is the cause of this ?*

The usual causes are :—Casing soil too wet or too dry, or damage by insect larvae. However as the beds subsequently cropped normally it would appear that in the initial stages of the crop the soil was too dry, but you happened to effect a cure unintentionally by watering a little heavier thus correcting the conditions and then maintained the requisite application suitable to your type of soil.

W. A. B. HARDING.

The complete answer to this question is that insufficient water was applied to the pin-heads. The pin-heads which are reported to have withered and died were actually formed on a surface moisture while the lower half of the casing was too dry.

I have conducted a lot of experiments lately which prove that with surface humidity pin-heads will form, but cannot develop unless immediately after their formation sufficient spraying is done to provide moisture throughout the root length of those pin heads in the casing. I am prepared to bet that the beds eventually cropped in the normal way because water was sprayed on in sufficient quantities for later flushes to mature. Had those first pin heads been fairly liberally watered for two or three consecutive days immediately they appeared, they would have developed. S. MIDDLEBROOK.

Q. 69. *Have you any information regarding the growing of mushrooms in chemicals and water ?*

Mushrooms can be grown in ' water culture ' but only at a prohibitive cost owing to the complicated apparatus which would be necessary. Such a culture is equivalent to laboratory cultures of various fungi or bacteria and strictly aseptic conditions would have to be observed. The slightest contamination by the outside air would result in various moulds and bacteria growing profusely in the liquid medium at a far greater rate than the mushroom mycelium and the only weapon against such contamination would be the introduction into the liquid of traces of a chemical antagonistic to the majority of moulds and bacteria and yet without affecting the growth of the mushroom mycelium. The possibility of achieving this is remote. McGREGOR BULLOCH.

Q. 70. *I have particulars of a 'Molonizer-Oxonian' unit which purifies the air and produces concentrated oxygen. Would this be beneficial in mushroom houses, and has anything of this nature been tried by mushroom growers?*

There have been no answers to this question which leaves us with the opinion that nothing has been tried in this field. EDITOR.

Q. 71. *What would be the result of attempting to grow mushrooms in manure where the horses are bedded with wheat straw and fed entirely on either lucerne or clover hay to the exclusion of any other fodder? Would an enhanced depth of bed off-set this irregularity?*

It is doubtful if a compost from this type of manure would develop sufficient food to support an average yield even if the beds were laid deeper. Firstly, there would not be sufficient organisms and heat produced to properly compost the manure, and secondly this type of fodder would not produce a rich enough dung.

W. A. B. HARDING.

Q. 72. *Can you tell me where I can get a 98% Nicotine for fly control, also Pyrethrum liquid for use as a spray, and what sort of a gadget does one use for spraying this on, and where can it be obtained?*

Failing your usual sundriesmen (Nicotine is in very short supply) the agricultural department of a chemist such as Boots or Timothy Whites should be able to supply both commodities. A 'Haws' type of special mushroom watering rose (obtainable from mushroom sundriesmen) is ideal for applying the spray, and can be powered from a pump worked manually or electrically. W. A. B. HARDING.

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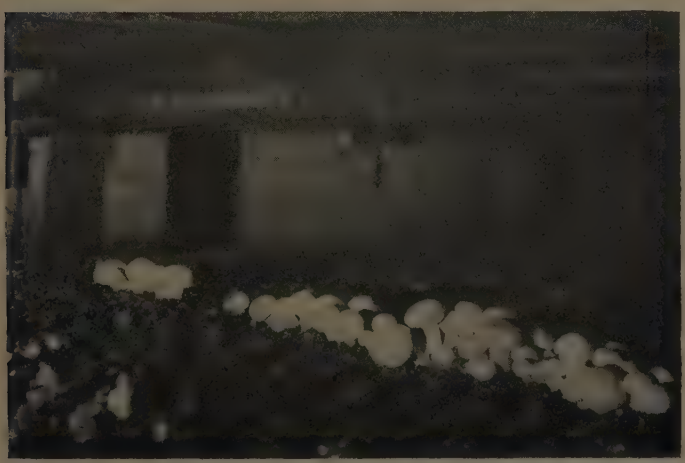
# Water IS Important!



**Messrs. Lindfield Mushrooms Ltd.** who supplied the above photograph write: Water condensed and dripped from a cold water pipe running immediately overhead. The house temperature was around 70°F. after spawning, and about 65°F. after casing. The result clearly shows the importance of moisture, for the line of mushrooms came up, as photographed, well in advance of the first flush elsewhere.

# OPEN DISCUSSION AT SECOND ANNUAL MEETING

**Held at the Restaurant Frascati, Oxford Street, London, on 27th November, 1948.**

**Policy of Ministry of Labour.** Mr. Duthy (Essex) raised the question of the Government's attitude towards labour in the Mushroom Industry. In his reply Mr. Atkins (Northamptonshire), stated that the present position was that horticultural workers were being called up, but farm and market garden workers were being deferred. Mr. Hovell (Worthing), who represents the Worthing and West Sussex Branch on the Glasshouse Produce Committee, said that the N.F.U. had taken the matter up strongly and any case of discrimination of this type should be reported fully to the Secretary in order that action could be taken. The Mushroom Industry was now on an equal footing with all other branches of horticulture and any suggestion otherwise was to be deprecated. Dr. Taylor had stressed this point in his speech at the Luncheon which all present had heard.

**Fuel Supplies.** There followed a long discourse on the fuel situation as it affected mushroom growers. Lt. Colonel E. Noel (Kent) stated that he had been refused his allocation unless he devoted less than 25% of his glasshouse area to mushrooms. Mr. Beerling (Kent) informed the meeting that although a grower under the control of the same authority as Lt. Colonel Noel, he had had no trouble in obtaining his supplies as usual. After further evidence of this nature, the Chairman summed up by saying that there certainly appeared to be differentiation between growers in the same area, and that members in difficulties should get in touch with the Secretary.

**National Mark Grading.** Captain Few (Sussex) brought up the subject of a National Mark Scheme sponsored by the M.G.A. Several members stressed the point that it would be very difficult to 'police' such a scheme and would throw too much work upon the M.G.A. Other members held that there was enough control in force to-day without any additions. Mr. Allsop (Scotland) explained that he had tried out a grading plan with the help of additional labour and that he had received top prices for all grades. By discontinuing the experiment he saved himself many hundreds of pounds. The Chairman then pointed out that Mr. Allsop was speaking of Northern markets, the London markets favoured grading. Captain Few said that in view of the great differences of opinion in the matter he wished to put forward the idea that the M.G.A. should concentrate on a recognised method of packing, not compulsory, which would serve to enhance the reputation of growers and get better prices. The meeting agreed that this matter be referred to the Executive Committee.

**Shortage of Chip Baskets.** A general discussion on the shortage of chip baskets followed, in which it was agreed that the position was common to all branches of Horticulture and that no priority could be asked for the Mushroom Industry. Other methods of packing were commented upon, but it was held that the chip basket was by far the most suitable.

**Area Meetings.** Mr. Baker (Surrey) proposed that some form of area meetings be held during the year. Mr. Atkins stated that this matter had been raised before. In his opinion the idea was a good one and could be linked up with 'Open Days.' The Chairman stated that the National Economy drive had rather hit this type of thing, but that the Executive Committee had the matter in mind, and hope to find some solution in the future.

**Election of the Executive Committee.** In his reply to Mr. Hovell, who asked if nominations could be sent in to the Secretary before the Annual Meeting, the Chairman said the idea was a good one, and he would like to add the attendances of each member of the Executive to the agenda.

**Watering Cans.** Mr. Rice (Sussex) brought up the fact that watering cans were in very short supply and that the position on some nurseries was serious. Mr. Hovell stated that the N.F.U. had done all in their power to get the position reversed and were still dealing with the case. The supply would ease later on, but at present nothing more could be done.

**Miscellaneous.** The Chairman, in introducing the new Secretary, Mr. Angus Watson, said that the Bulletin office had been transferred to Yaxley, and that all queries should now be addressed there. In his reply, Mr. Watson said that he was glad to have the opportunity of meeting so many of the Members. He had made a lot of new friends since joining the M.G.A. and hoped that he would be able to make more in time to come. All members were interested in what went on in the M.G.A. and this made what could be a dull routine job into a very interesting one.

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# A Mushroom Grower's Diary

*I asked a prominent member of a certain Agricultural Executive Committee if there was any possible way to by-pass the intolerable delays in obtaining permits, recommendations, sponsorings, official replies to letters, etc. He answered emphatically "NO." I gained the impression that he enjoyed saying it, too.*

. . . . . .

*After visiting several colossal nurseries in the Worthing area I am rendered speechless both by the magnitude of the tasks these people have set themselves, by their consistently high production from such areas, and by the complete insignificance of my own plant. Never again must these notes of mine reflect the authority of vast experience. (I think I hear the heckler saying "they never have done!"). One should be able to learn a lot from this vast scale production, but frankly the whole thing is too big for a small mind like mine to absorb. One can admire but not imitate.*

. . . . . .

*It would be interesting to know how many words there are for the process of cleaning the beds. I know of trashing, rooting, stumping, coring, chogging, and just—cleaning.*

. . . . . .

*Will the Tray System become popular in this country? Within one week I have heard of three growers—one large and two small—who are experimenting. I must look into it, though I imagine it holds many snags for growers who cannot afford expensive air conditioning.*

. . . . . .

*Two houses of entirely different construction were filled with the same compost, spawned together, and cased together. One has done 1 lb. to date while the other has barely started, despite a very full spawn run, and shows no signs of making good. There is nothing wrong with the house as it has been known to produce over 3 lbs. in quick time—so the explanation doesn't seem to be there.*

. . . . . .

*I feel sure a prolonged period of high outside humidity plays havoc with one's watering inside. There can be few growers who would disagree with this. Shall we ever overcome this "variable"? What would be the cost (and the design!) of a house entirely independent of outside air conditions?*

. . . . . .

*As a result of my "looking into" the tray system I have instituted many enquiries without finding a suitable tray. I have heard of one or two growers who purchased boxes very cheaply indeed—in fact as low as 6d. for a box 18″ × 12″ × 9″. The nearest approach to this was one offered me by the Timber Control, size 24″ × 12″ × 8″ for 10/- a time. At this rate I am prepared to let others do the experimenting.*

. . . . . .

*The two houses referred to above have continued as they started. One has produced nearly 2 lbs. and the other 0·3. The 0·3 house is now being emptied. There seems to be nothing wrong anywhere. Still a good spawn growth. Same soil and treatment used in both cases. A laboratory analysis of a block of compost and soil shows no disease or pest contamination.*

. . . . . .

*Out of 13 crops laid down in 1947 the first 6 averaged 0·6 per sq. ft. with nothing over 1·1. The next 7 averaged 2·4. Quite a jump. Explained, I think, by a deliberate change in watering methods, though I don't rule out (a) the possible coincidence of sudden though unknown and unobserved improvement in composting (or raw material), and (b) the change in weather last September (though the crop improvement started before the weather changed). One big grower, working on the weather argument, is prepared to bet I can't maintain the high average through the coming summer. So am I, but for a different reason! I can never guarantee anything here.*

. . . . . .

*I am so convinced that hand firing of boilers is a methcd so out of date, so prehistoric, so inconvenient, wasteful and expensive, so completely unsatisfactory from a temperature control point of view, that I have bought and am to-day installing a mechanical stoker. I still think, however, the ideal is oil firing, but besides being very expensive to instal, it is not now possible to obtain fuel.*

. . . . . .

*Received a cutting taken from a daily paper of an article headed "Mushrooms 9d. a lb." It is the usual simplified instruction for the beginner. It contains, however, one very curious statement concerning spawn growth. A fortnight after spawning, it says, you will find spawn has turned to . . . . . But read the comments of the M.G.A. member who sent the cutting. "I started growing mushrooms over 20 years ago. I have never achieved the success I think I deserve. I did not know the secret. You see I have never waited till the spawn turned to—a sort of syrup."*

# THE TRUFFLE PROBLEM

*by*

**Dr. A. M. KLIGMAN**
*Ph.D., Mycologist*
*(Hon. Member, M.G.A.)*

★

The invasion of mushroom beds by the " Truffle " is becoming increasingly severe. The prevention of this disease has become the number one problem of many growers.

There is among mushroom growers an enormous amount of misunderstanding and wild theorizing about this disease. Despite the fact that our knowledge of " truffle " is far from complete, there is sufficient information on hand to be of real help in prevention of this disease. To help accomplish this, the following discussion may be of aid.

## WHERE DOES TRUFFLE COME FROM ?

It seems almost certain now that the original source of the " truffle " is the **soil.** We have succeeded in isolating it from a sodded field which never had any direct contact with spent manure. In fact, a grower who composted a pile of manure over this fresh sod had an enormous loss from truffle in every bed filled from this pile. To make the picture more striking, this same grower composted manure from the same source at the same time on a regular hard packed composting ground not far away from the sod. The beds filled with this manure never developed truffle. An English investigator has had almost the same experience. Additional evidence pointing to the soil as the source is afforded by the fact that closely related species of fungi also live underground. This is the case with the famous edible truffle grown in France which is dug out of the soil by trained pigs. Because of the fact that the disease is now so widespread in the industry, **the greatest source of truffle spores is the mushroom house itself,** and we must now think of the problem in terms of the fact that the spores are probably present to some degree every place where mushrooms are grown.

## WHAT WILL KILL TRUFFLE SPORES?

Truffle spores are extremely resistant to heat. They are killed at a temperature of 180° F. in 5 hours, a temperature obviously impossible to attain in the "sweat out" or while steaming soil.

As yet we know of no fungicides which will definitely kill the spores. Among the compounds which have been tried without success are: Formaldehyde, sulfur dioxide, chloropicrin, chlorine gas, copper sulfate, mercuric chloride, cresol, lime, sulphur, Fungidex and Elgetol.

We are at present investigating a new series of compounds and may be able to report on these later. At any rate the important point here is that we have no practical way of killing truffle spores. **We are thus forced to rely entirely on methods of prevention.**

## DOES TRUFFLE LIVE OVER IN THE BED BOARDS?

There is absolutely no doubt that truffle spores can live over in the bed boards and reinfect the next crop if conditions are right. Truffle grows and fruits well on bed boards, as has been observed many times and can easily be demonstrated in the laboratory. In fact, if the boards are old and have many crevices and cavities inside, one can frequently find fruiting bodies (calves brains) within such crevices when the board is cut open. Thus, after a few successive years of truffle, one can readily appreciate how the spore load in the boards can become enormous. Again it must be remembered that there is no practical way to eliminate these spores in the boards.

## WHAT CONDITIONS ARE FAVOURABLE FOR THE DEVELOPMENT OF TRUFFLE?

Every grower who has had experience with truffle knows that it is principally a disease of warm weather. In the laboratory it can be shown that the truffle grows best at a temperature of 80-85° F. whereas the mushroom prefers a much lower temperature.

In addition, there are unknown factors in the compost which decidedly influence the growth of truffle. Not all compost or spawn as it is found in mushroom houses will support the growth of truffle. We have collected many samples of spawn from the houses of various growers and invariably it is found that truffle spores simply will not germinate in some of these samples. Again, in doing experiments on truffle the earliest investigators quickly discovered **that truffle frequently failed to appear in beds that were deliberately infected with it.** It is impossible to gain a clear understanding of the truffle problem without appreciating this fact. Indeed, it is precisely because truffle does not always develop in beds infected with spore that there is so much dispute and argument about this disease.

If, for instance, a grower has a house badly infected with truffle and finds on the next crop that none of it appears in the same house, he will usually attribute this good result to some fungicide or special procedure which he used. This happens frequently and the real fact of the matter is that truffle probably did not develop because the temperature was fairly low or for unknown reasons the compost was not suitable for its growth. It is most unlikely that in the above illustration there

were no spores carried over in the boards, especially if they were old. The real reason why the truffle didn't appear is because the spores **failed to germinate.** This point cannot be emphasized too much and is the feature on which we base our attack on this weed fungus.

## UNDER WHAT CONDITIONS DO THE SPORES GERMINATE?

The truffle, like other species of fungi, has 2 phases of growth: a mycelial or vegetative phase in which the growth is made up of fine threads and microscopic filaments. This stage is usually not observed. The other phase of growth is the fruiting stage in which the characteristic "calves brains" appear. The spores, or tiny "seeds" which reproduce the fungus, are borne **within** the "calves brains." The mycelial or thread phase is sometimes seen on the bed boards and can be easily killed by drying. On the other hand, the spores are not killed by drying and can survive till the next crop.

The spores are not released until the "calves brains" become reddish brown and begin to decay. The germination of these spores produces the mycelium or thread phase.

**The specific condition which prevents the germination of truffle spores is low temperature. Upon this fact is based our whole programme for the prevention of this disease.**

At a temperature of about 60° F. truffle spores will not germinate. It makes little difference whether or not the manure is loaded with such spores. Once the spores have germinated, however, the truffle will grow at any temperature that the mushroom will, and it is then too late to prevent the disease by dropping the temperature.

The critical period during which the temperature must be at 60 or 65° F. is while the **spawn is running.** It is during this time that the spores are going to germinate if at all, since the temperature will be too low anyway after the houses are cased. Of course, running the spawn at 60° F. will slow down the crop somewhat but this can be overcome, if necessary, by planting more spawn. If only one crop is planned, it is important to delay planting until all danger of hot weather is over. If the two crop system is used one should keep the temperature at 60-65° F. whenever the weather permits. A grower who is hard hit by truffle year after year should never try to guess about the weather since each successive infection adds to the spore load present in the house and aggravates the problem of control.

One grower who had serious losses for many years completely eliminated it from his plant by growing his spawn at a lower temperature.

## DOES TRUFFLE SPREAD AROUND THE PLANT FROM ONE SPOT TO ANOTHER?

Ordinarily truffle does not spread from one spot to another in mushroom beds. There are several reasons for this. First of all the truffle seldom begins to appear before the 1st or 2nd break and by that time even though the spores did spread around, the temperature would ordinarily be too low for their germination. Moreover, these spores are borne **inside** the calves brains, many of which are underneath the surface. As a result, the spores are not spread about in any quantity until the house is cleaned out. On numerous occasions, we have tried to infect new areas in the bed during the production period by deliberately

spreading the spores around on and under the surface. In no case did an infection result. In all of these cases the temperature was under 65° F.

There is one condition in which the disease may spread from one bed to another. Certain growers attempt to limit the spread of truffle by digging out the infected area as soon as it appears. If during this procedure some of the infected spawn drops down onto the next bed, the truffle mycelium in the compost may continue to grow and result in a new infection. It is to be noted that it is **not the spores** in this case which are responsible but the actively growing truffle mycelium. There is no opportunity for truffle mycelium to be spread about unless one actually digs up the bed, hence, this method of spreading can be discounted from the practical standpoint, although we have seen this happen.

If, as frequently happens, new spots of truffle appear at different times in the beds, this is not because the disease has spread from the original spot but rather because truffle spores were originally present in these areas.

## HOW DOES TRUFFLE GET INTO THE HOUSE?

There are several avenues of entrance for new truffle spores to get into a house although it seems likely that in many cases the spores simply live over in the house from one infection to the next. As stated above the original source of the truffle was probably the soil and it is hence easy to guess how the disease entered the house.

1. **The manure may be contaminated by spores.** This can happen if infected soil is added to manure. Very few growers nowadays add soil to manure and in general this is a practice that should be condemned. Again, manure can become contaminated if it is composted over sod which contains truffle. Obviously another source of contamination occurs when infected spent compost contacts fresh manure. This contact need not be direct since careless disposal may release large numbers of spores into the air where the wind may carry them into fresh piles. It is extremely difficult to estimate how important the wind is as an agent for dispersing spores but this possibility is certainly to be kept in mind.

There is no evidence that manure as it comes from the stables is infected.

2. **The casing soil may be contaminated.** The most obvious way for this to happen is the careless disposal of spent compost. Never dispose such compost in a region where casing soil is later going to be secured.

Spores brought in with the soil at casing time are probably of lesser importance than is generally imagined. This is so because the temperature is generally lowered to 60° F. after casing and it will be recalled that spores do not germinate at this temperature. In general, it is the spores present during spawning that are of greatest importance because the temperature is more suitable during that period.

3. The spores that live over in the bed boards perhaps play the major rôle in reinfection of the crops. Each year that truffle appears, the residual spore load in the boards increases. It is definitely known that truffle spores maintain their ability to germinate for 2 years and in all probability can survive for much longer than this.

## WHAT SHOULD BE DONE WHEN TRUFFLE APPEARS

No standard rules can be given for management of truffle after it appears. In fact, none of the procedures to be described are entirely satisfactory.

If one has a small spot or just a few spots it may be advisable to just totally dig out the infected areas, taking out at the same time the compost 2 to 3 feet beyond what is obviously infected. The reason for this in not because of the danger of the disease spreading around but simply to remove the truffle before it has fruited and produced spores. It is a method of **keeping the spore load down.** This must be done early while the calves brains are white and before they have begun to decay and to release spores.

If it is obvious that truffle is appearing in many different spots it is impractical to dig out all these areas. If such areas are detected early enough, one can employ a strong solution of Fungidex or other fungicide and thoroughly drench the infected spot. This procedure is useless if performed after the calves brains have been formed for a week or two since by that time the spores within have matured and cannot be killed. Again, the objective is to **prevent the formation of spores** by killing the young fruiting bodies. It is to be appreciated that no more mushrooms can be expected in areas treated with the drench. This is really not a form of treatment, it is simply prevention insurance aimed at keeping down the spore load within the house and not at limiting the spread of the truffle from one spot to another.

Unfortunately, the truffle frequently fruits under the surface and the infected areas are not seen until mushroom production is cut down. By that time, it is often too late to drench the area because the calves brains have already produced their spores. It is obvious that the drench method has a limited use and is only worthwhile if a thorough search for new spots of infection is made.

In a fair number of cases one will find that the compost under infected areas seems to contain perfectly healthy spawn. When this happens, it is possible to salvage a part of the crop by drying up the infected areas. When water is again applied as much as 50-75% of the normal crop can be induced to appear. This cannot be done if the compost under the surface is dark, soggy and devoid of spawn.

It is to be noted that under this plan of management, the effort is directed at saving part of the crop and completely neglects the fact that a large number of spores are going to be produced which will invite reinfection on the next crop.

Because of the extreme inadequacy of all forms of treatment, the emphasis must be placed on **prevention.**

## SHOULD A HOUSE THAT HAS HAD TRUFFLE IN IT BE SPRAYED AFTER IT IS CLEANED OUT?

It has already been pointed out that there are no fungicides presently available which will kill truffle spores. Nevertheless, it is probably a good practice to spray a badly infected house with double strength of a fungicide such as Fungidex. The reason for this is that if

the boards are saturated with the fungicide, the young mycelial threads produced by the germinating spores may be killed before they have the opportunity to infect the spawn. Certainly, the spores are not killed by this procedure but rather the mycelium which emerges from the spores. A fungicide which is water soluble, which does not evaporate, and which has good penetrant action should be used. It is our feeling that Fungidex is the most useful of the fungicides for this purpose. At the same time, it can be frankly stated that we do not know whether saturating the boards with Fungidex will be of real value in this case. On theoretical grounds, it certainly would seem to be worthwhile for the reasons given above.

**In conclusion, we believe controlled temperature to be the best means of fighting this disease.**

# CORRESPONDENCE

## WHEN SHALL WE MEET?

I am writing to ventilate a point that has been raised at both Annual Meetings but not pursued. I refer to the day of the week which the majority of Growers, especially the small Grower, might find the most convenient for Annual Meetings, ' Open Days,' and so forth.

I believe the average small Grower finds himself playing an integral part in the daily round on his Nursery and therefore it is hard for him to break away at just any time. Personally I am inclined to find myself anchored to my Packing Room, and so the answer in my case is Saturday, because that is the only day in the week when I do not regularly dispatch mushroom consignments.

I hope other Growers will write to you, Sir, agreeing that Saturday is the best day of the week for the Annual, and any other, Meetings and then perhaps the Executive Committee may take the hint.

CAPT. M. E. FEW.

MR. F. C. ATKINS comments: I feel sure the Executive will welcome the views of all Members on this point. As one who was responsible for fixing the dates of previous meetings, I would point out to Capt. Few and others living near London that a number of growers living hundreds of miles away expressed a desire that week-ends be avoided, as certain trains (and certain railway systems) do not work on the Sabbath—which meant they might not be able to return home until the following Monday.

## CANNING MUSHROOMS FOR EXPORT

*Mr. M. ALAN CONDELL (Messrs. Thomas Elliott Ltd.) writes:*

We have been giving some consideration to a matter which we think might usefully be discussed by the Association at one of their meetings.

We are aware that a North Country firm can mushrooms, 6 ounces per tin, which sell at 8/- Retail, and it may be that the M.G.A. under a National Mark Scheme could develop a Company to can the produce of their members which would be materially helpful during "glut" periods.

Admittedly, the enterprise would conceivably force down the home market Retail Price of the product of the Newcastle firm to get in, but we are inclined to think that the enterprise could launch out in other directions by going for Overseas Markets, particularly in tropical climes where the import of fresh fruit and/or vegetables are limited by the duration of freshness of the produce.

The essence of a good delivery is "speed" and if mushroom growers became "air-minded" by sending their products by air to overseas markets we think that every assistance would be given by the Government as it would be a means of obtaining foreign currency.

Similarly, we think that the Government would give every assistance to get a factory going for the Export Canning of Mushrooms, and now that mushrooms have been designated a food, it is probable that all departments would co-operate.

This is intended as an idea to form a basis of discussion.

## CONTRIBUTIONS FOR RESEARCH WORK

*Mr. M. ALAN CONDELL (Messrs. Thomas Elliott Ltd.) writes:*

We all realise that Research Work costs money, and whilst some members of the M.G.A. have contributed to this research in the formation of the Mushroom Research Association, there are not many members in comparison to the number of known growers.

Ultimately, in a roundabout way these non-members derive some benefit from the work carried out by the M.G.A., as when non-members get with members and discuss their problems something comes out which assists them to better themselves, and we feel that your Executive Committee should consider ways and means of making each and every grower contribute to the work of Research.

The suggestion we are about to make may be unworkable, but it will, at least, serve to form a basis for discussion and it may have far reaching results, not only for the betterment of the Mushroom Growing Industry, but for other forms of horticulture in general, and for the Mushroom Industry, in particular.

Could the co-operation of all Market Salesmen be sought where by a percentage (¼% or ½% or 1%) from sales be deducted or levied on sales of all mushrooms, in the markets, all over the country, payable to the work of Research (*a*) Mushroom Research Association and/or (*b*) the M.R.A. and other research bodies in a proportion to be agreed and/or (*c*) between the M.R.A. and other bodies and institutes entering into research in all forms of horticulture.

No doubt you being more closely associated with growers and their problems can put feelers out and discuss the point with them before the matter comes up for discussion at an Executive Meeting.

[*The views of salesmen on this suggestion would be particularly helpful.*
*—Editor*].

# COMPLEX PROBL
# IS D.D.T. HARMFUL? A.G.M. D
# SUB-COMMITT

A most interesting discussion on D.D.T. was initiated by Mr. Fred. C. Atkins after the Annual Meeting in November. He asked whether mushroom growers were running any risks by using D.D.T.

" Someone early in 1947 suggested it was ruining his crops, and since then many growers I know have stopped using this first-class insecticide—just in case it is harmful," said Mr. Atkins. " Don't you think we might investigate this problem and see if we can get some concrete evidence for or against? If necessary, we might instigate some research, though this would depend on the cost involved. I have been to University College, Nottingham, to discuss this important matter with the Head of the Botany Department there, Professor C. G. C. Chesters, and he has explained to me the magnitude of the problem. At the same time he has undertaken certain limited experiments to demonstrate what effect D.D.T. has on mushroom mycelium in culture."

(Prof. Chesters' notes are given on a later page.)

The speaker added : " Don't you think we should pursue this point? If D.D.T. is harmful, we must leave it alone. If it is not, let us take full advantage of it."

Mr. F. M. M. Beerling : I think Mr. Atkins' suggestion very excellent. I should also like to see included tests of Gammexane.

Mr. H. Dyke : I had a terrific flush—so great that I practically had to re-case the bed. Before doing that I found one or two maggots and D.D.T.'d them. Up to now the other flush has not come through. Wherever I look, where the bed is bare, I find D.D.T. around.

Dr. H. V. Peet : While I entirely endorse Mr. Atkins' remarks on this subject, it is most necessary to investigate the use of insecticides. One must remember that the problem is most involved indeed, and that a great many of these insecticides are not applied in general practice as the pure insecticide ; they are compounded with other substances, solvents and emulsifying agents. You have many forms of D.D.T., and it is easy to gain a wrong impression. One grower may say D.D.T. is doing damage, whereas in fact it may be what is made up with the D.D.T. which is to blame. Similarly with all other insecticides. If one is to carry out experiments—say with D.D.T. then one should logically compare D.D.T. with the other insecticides which may be used, because a great many of them to-day have certain fungicidal properties as well.

Mr. H. L. Coulson : I have covered my beds with 5% D.D.T. powder and cannot see that I have had ill results. I have had marking of the mushrooms when the place has been damp and have used Aerocide most successfully and had swarms of violet-coloured springtails go into a corner.

# FOR RESEARCH
## CUSSION ON THIS QUESTION
## APPOINTED

Mr. E. D. Sparkes: At Lingfield nurseries we have had interesting experiments which I carried out myself. I was surprised by the kill of mushroom fly and thought :—" Here is a good thing, I can make money." I took over an agency without realising possible implications. Shortly after, D.D.T. had its great boost and, as with penicillin, there came about criticisms, etc. I began to wonder if I were wrong, and in the nurseries I have mentioned, D.D.T. in this form or any form was stopped for three months. Practically, I have used D.D.T. for two years and on this nursery in question it has been used for two years minus those three months. To-day I have verified that there was no difference in the yield from this particular nursery throughout those three months. If we find something wrong with our mushrooms we would rather put it down to something outside our own experience and field. I have an entirely open mind on D.D.T. and still do not know if it causes damping. I asked Mr. Atkins if he could help. Dr. Bels has used D.D.T. and I hope he will tell us his results. I am very interested to know if there is any scientific proof of damage by D.D.T. and not just prejudice. Prejudice is a fiend which gets in the way of any advancement. Scientific results can only be judged by careful examination of two plots having identical properties ; that is very difficult to get with mushrooms.

Dr. P. J. Bels: I have just started work with D.D.T. I have not used the fumigant. I always mix my manure with D.D.T. and have seen in several plots some differences. You can use too much D.D.T. in manure. I have only one kind of D.D.T. but several different bases are used. I think you can use D.D.T. but must not use too much. In my investigations with fumigants I always dust round the whole house as well as mixing it with the manure. I have only just started these experiments.

Mr. Atkins : What does Dr. Bels mean by " too much ?"

Dr. Bels : I do not know the exact amounts by heart.

Mr. Atkins : Will Dr. Bels write and tell us ?

Dr. Bels : Yes.

Dr. R. L. Edwards : I have two comments to make on the discussion. As to the use of D.D.T. in the compost heap, it is well known that D.D.T. breaks down fairly rapidly if it is heated under alkaline conditions and forms hydrochloric acid. Using a lot of D.D.T. in a manure heap you may well get local patches of acid formed. This is less likely to happen when D.D.T. is put on the bed in the house after peak-heating. You will not get a rapid release of hydrochloric acid there. You are more likely to have trouble if you put it in the heap than on the bed.

The other thing is that recently I saw reference to the effect of D.D.T. on bacteria and moulds in some work done at a Canadian Research Station by the Canadian Ministry of Agriculture and a few days ago I had a letter giving details of that work. They tried D.D.T. on pure cultures of four bacteria and three moulds of different kinds, none of them closely related to the mushroom, but they found no effect at all, using much higher concentrations than you could get in a mushroom bed. They found no effect on the growth of these organisms, although a very high concentration did slightly delay fermentation of sugar by yeast. The other thing is that D.D.T. and Gammexane have both been tried in bacteriological laboratories as a means of keeping mites out of pure cultures, as mites are a nuisance in cultures. I don't know which organisms were being grown there, but D.D.T. had no effect on these organisms. Gammexane did keep mites out and, in some cases, delayed the growth of the moulds.

The Chairman : There seems to be enough confusion to justify a proposition that we should have an investigation if possible.

Mr. Atkins : I will propose that we go into this a little further, see how much it costs, and that we make, if we can afford it, a contribution towards the cost of research into this question. I think there are interested parties who might help us. It is a much wider question and of much wider interest than that of the mushroom industry alone and the Agricultural Research Council may well view this favourably and contribute a little. I propose :—" That the Executive Committee sees what it can do to get an answer to this problem."

Mr. A. G. Pointing : We found flies thrived on D.D.T. Dr. Edwards has seen round our houses and he told us we had less flies than he had seen in a recent tour. With smoke bombs we found we have no flies at all. I suggest we include Gammexane smoke bombs ; we found them very satisfactory.

Mr. Atkins : Would you like me to include GAMMEXANE with D.D.T. in my proposition ?

Mr. Pointing : Yes, we found Gammexane smoke bombs do all that was necessary without using Gammexane or D.D.T. in the compost or on the bench beds.

The Chairman : Quite a number of people will not use Gammexane because of its smell. Those who have used it know its properties as a killer and its persistent effect. Another argument I have heard is that the mushroom produces its own perculiar smell in the house and many practical growers test the condition of a house by the smell as they go in. Gammexane puts that out of court and they will not use it. I think they are foolish, but they will not. For my part I would say that we investigate D.D.T. only, but if you like to include the other, no doubt the Executive Committee will see what can be done.

Mr. H. S. Allsop : Do you use the smoke bombs while the crop is on the beds ?

Mr. Pointing : Yes, and we have never had one complaint of tainted taste. If you put powdered Gammexane on the beds you get the smell

retained; if you use smoke bombs, after about 24 hours you cannot smell it. But the effect lasts. We do our houses with smoke bombs once a fortnight with the crops on.

Mr. J. B. Morris: I have used liquid Gammexane for twelve months and it kills everything. I tried the mushrooms on friends and there were no complaints, they said they were the finest they had ever tasted. The markets never said anything and I always get top price.

Mr. Sparkes: If the Executive Committee cares to carry out the experiments I will undertake to supply, within reason, quantities of any insecticides that can be volatised by smoke and I hope that other people dealing with insecticides in a similar way will also co-operate.

Lt.-Col. E. Noel: There are two points, the influence of D.D.T. and Gammexane in the house itself and on the compost heaps. Our trouble is more with flies on the compost heaps. We have found Gammexane very effective in keeping them down, but I understand from Dr. Edwards that there is a danger of turning the manure sour. I would like to have investigated the question of controlling flies on compost heaps.

Mr. F. M. M. Beerling seconded Mr. Atkins' proposition, which was put to the meeting and carried.

## PROFESSOR CHESTERS ON D.D.T.

Professor Chesters writes (16th November, 1947): So far as available reports on recent researches are concerned no reliable information regarding any effect of D.D.T. (dichlorodiphenyltrichloroethane) can be obtained. Morris has examined its fungicidal effect against certain pathogenic species and at least one partially saprophytic species and has concluded that it is without value in this respect. The problem of its direct effect on *Agaricus campestris* mycelium is therefore still open to investigation, and certain very limited trials are being initiated here, but there remains the wider problem which may possibly be of some interest to mushroom growers—the effect of D.D.T. on the microfauna of the mushroom bed and the resultant of any such effect upon (*a*) the growing mushroom mycelium and (*b*) the very numerous saprophytic fungi and bacteria which are associated with such microfauna.

On first principles it would seem logical to suppose that any factor which affects the balance or the usual course of development within a mushroom bed will cause some effect on the mycelial development not only of mushroom but of its associated mould population. This is a matter for experimentation but the complexity of the problem is such that clear evidence of the actual and measureable harmful effect of D.D.T. on mushroom beds should be obtained before further investigation is considered. If the Mushroom Growers' Association is convinced that such effect is an established fact, then the major problem can at once be investigated. This would involve:

(*a*) a consideration of the effect of D.D.T. on the protozoan fraction of the mushroom compost and subsequent investigations of its effect

on more advanced components of the fauna of such beds considered under the headings of

(i) direct effect

(ii) indirect effect by the protozoan population.

(*b*) a consideration of any effect of D.D.T. on the protozoan population in relation to the bacterial flora and the bearing of any such established effect upon

(i) carbon/nitrogen decomposition

(ii) the associated mould population.

(*c*) a consideration of any effect of D.D.T. directly upon the growth of the mycelium of *Agaricus campestris* in compost.

There are other lines of development of this problem which are consequent upon any clearly definable effect of D.D.T. at any one point in the series given above but enough has been written to show that the problem is complex and cannot be regarded as entirely centred round the living mycelium of *Agaricus campestris*. If there is an effect I should expect it to be more closely related to the habitat of the mycelium than to the actual inhibition of mycelial growth by direct contact. Any major change in habitat within a compost will set in motion subsequent cycles of change which may have far reaching effects.

It would appear that the first essential is that the Mushroom Growers' Association should be fully convinced of actual yield reduction due to the use of D.D.T. before pursuing a matter which may be highly complex.

## DR. E. B. LAMBERT'S COMMENTS.

Dr. Edmund B. Lambert writes from Pennsylvania, U.S.A. (25th November, 1947): We have had evidence of reduced yields from spraying mushroom beds with wettable suspensions of D.D.T.; on the other hand using D.D.T. as a powder in a small quantity necessary for dusting at spawning time does not seem to adversely effect the mushroom yields. We do not however in this laboratory advocate the use of D.D.T. powder directly on mushroom beds because there has been so much evidence with other crops that the D.D.T. may be absorbed in quantites sufficient to be poisonous.

Small-scale experiments have been made in the Department of Agriculture in which there is preliminary evidence that the mushrooms do absorb a small amount of D.D.T. when they are grown on treated beds. This work is still very much in the experimental stage and as I said before we do not feel justified in risking possible poisoning of our consumers.

I am told that the Department of Agriculture found it necessary to condemn thousands of bushels of potatoes last fall because of the amount of D.D.T. accumulated in the potatoes as a result of spraying the vines.

## WORK IN THE UNITED STATES.

Asked by the M.G.A. what was being done by the U.S. Government, Mr. C. A. Weigel, Senior Entomologist at the Beltsville Bureau of the Agricultural Research Administration, informed us on 8th January, that :—

None of the data on the use of D.D.T. in Mushroom Houses has thus far been published by us since we desire to obtain more extensive and corroborating data. However, you may be interested in the following information based upon last season's work.

During 1946-1947 we conducted some preliminary tests to obtain information on whether D.D.T. when applied to the surface of the casing soil in mushroom beds would result in the mushrooms absorbing any D.D.T. In these tests the insecticide was applied at the rates of 2·5, 5, 10 and 20 lbs. technical D.D.T. per acre respectively. To obtain a more even distribution a commercially prepared dust containing 10% D.D.T. was made up as a suspension in water and applied to the bed surface with a specially built watering can provided with a " rose " nozzle. Analysis for D.D.T. absorption was made only on the mushrooms that were harvested from the beds that received the 20 lb. dosage. It was felt that if no D.D.T. was absorbed at this dosage it would obviate the need of running analysis on the lower dosage lots.

The analysis showed that 2 p.p.m. of D.D.T. was absorbed by mushrooms picked within a week after application. However, mushrooms from these same plots picked a month from the time of the last D.D.T. application, and after the beds had received a total of 3 applications at 2 to 3 weekly intervals of the same dosage only showed a trace of D.D.T.

The data also shows that there was some reduction in total yield for the 20 lbs. per acre treatment. No reduction resulted in one test where a 50% wettable D.D.T. powder suspension spray was applied at a dosage of 10 lbs. per acre.

No definite conclusions can be drawn from these preliminary results since they represent only one season's work. We have recently initiated another series of tests in which the method of application is being varied.

In addition to maintaining an untreated check, D.D.T. is being applied at the rate of 20 lbs. per acre in the following manner : (*a*) immediately after spawning, (*b*) just prior to casing the beds, (*c*) after casing the beds, and (*d*) a combination of treatments (*a*) and (*c*). In this instance, however, only one-half the quantity (10 lbs. D.D.T. per acre) is being used per application. It is planned to have analysis made on each " flush " to find out if any D.D.T. is absorbed and how long after application do the mushrooms take it up.

The Department has not recommended the use of D.D.T. to the industry, but it is our understanding that large quantities are being used especially in the area around Kennett Square, Penna., which is the largest mushroom producing area in this country. It is being used to control the adult Phorid and Sciarid flies by applying a suspension

spray to the woodwork around doors, ventilators and sides of the benches in much the same manner as it is used to control flies in general in stables, dairies and the like.

Apparently this method is proving quite effective in reducing the population of the mushroom flies, but it does not control those adults or the larvæ in the compost in the beds. Therefore, this treatment must be supplemented with application to the compost of some insecticide. For this purpose D.D.T. seems suited provided it is effective and is not absorbed by the mushrooms.

According to our present knowledge no D.D.T. is being applied directly to the growing crop because of the possible danger of harmful quantities of D.D.T. remaining as residues or being absorbed directly by the mushrooms. The growers are fully aware of this danger and are, therefore, anxiously awaiting the results of the tests that we and other investigators are now conducting on this phase.

We note from your letter that you propose to instigate research into these problems and that you would like to exchange ideas and data on the subject. We welcome this opportunity and shall be glad to do likewise. In connection there has recently come to our attention an article by F. W. Allerton, published in *Fruit, Flower and Vegetable Trades' Journal* V. 90, 10th September, 1946, covering work done in England. The general title is "D.D.T. in Horticulture." The last paper in the series is on "The Uses of D.D.T. against Mushroom Pests." We are wondering whether by any chance you were associated with any of these studies. According to the author, D.D.T. was used at the time of turning the compost pile as well as on the growing crop. While the results report effective control of Phorid and Sciarid flies with D.D.T. dust and emulsion, no mention was made of any possible residue or absorption by the mushrooms.

## MR. ALLERTON'S COMMENTS.

We asked Mr. Allerton, Technical Adviser to Messrs. Geo. Monro Ltd., for his comments on this last paragraph. He replied (26th January, 1948) :—

The point which you raise concerning the absorption of D.D.T. by the mushrooms is most interesting. So far as I know, no analyses have been made in this country to determine whether this crop does take up the insecticide or not, but on general considerations it would seem rather doubtful.

In the article mentioned, I was merely passing on the information which we and our customers had found in relation to the use of D.D.T. on mushrooms, and no attempt has been made to investigate the matter beyond the control of certain pests and diseases of mushrooms by D.D.T. preparations.

I should, however, be most interested to know whether you are able to determine that D.D.T. is in fact taken up by the mushroom. If this proves to be the case it would seem to open up a wide field of research in regard to other insecticides, such as Nicotine. I await your further information with interest.

## THREE PERTINENT QUESTIONS.

Professor Chesters added later (*25th February*, 1948) :

In the initial series of tests on pure culture on agar, D.D.T. vapour and spray made not the slightest measurable difference to the growth of *Agaricus campestris* mycelium. A second series is now in course of development, but the mycelium will not be ready for spraying for quite another 10 days. This time I am using heavier concentrations and may obtain some result, but I am doubtful. The fault with this type of experiment lies in the fact that the really significant factor—absorption of D.D.T. by the mycelium—is not being measured and I so far cannot find any suitable analytical method of estimating absorption of small quantities of D.D.T. Also, effect of D.D.T. on mycelium is only one side of the problem.

We then asked Professor Chesters three questions, and his tentative replies are given in italics :

1. What form should research into this problem take ?

*Research into effect of D.D.T. on insect population (entomologist required here) of compost ; on microbial population and mycelium in compost ; absorption of D.D.T. by mushroom (mycological problems—mycologist required). Research on commercial beds, which might require to be modified to suit experimental conditions.*

2. Who would undertake it ?

*Person undertaking research would require to have mycological and some entomological knowledge and be able to undertake analyses of D.D.T. Quite a few qualifications for one man.*

3. How much would it cost ?

*Very difficult to say, but about £300—£350 might well go in salary to the research assistant. (I have been wondering whether the pest control station at Slough have any knowledge of D.D.T. as applied to food products in general and whether they might not be able to help you for less outlay, but I have not been able to make contact with them yet).*

## D.D.T. SUB-COMMITTEE SET UP.

**The March meeting of the M.G.A. Executive Committee appointed Mr. Fred. C. Atkins, Mr. E. D. Sparkes and Dr. R. L. Edwards as a Sub-Committee to carry inquiries further.**

# Hygiene on the Mushroom Farm

R. L. Edwards and C. J. La Touche.

We believe that there is room for improvement in the control of mushroom disease in general, as at present practised on many farms. Therefore, in this article we suggest some simple measures of control which are based on existing scientific knowledge.

The principle " Prevention is better than cure " is as applicable to mushroom hygiene as it is to the administration of public health, and likewise is directed against disease in general instead of against diseases in particular.

Mushroom disease is usually caused by bacteria or moulds, most frequently the latter. The spores of moulds, which represent the latent and most resistant stage in the life of these organisms are usually responsible for the introduction of disease in the mushroom house. Almost invariably also, if they are allowed to develop to maturity they produce more spores, millions of them, on the premises, each one potentially the source of another patch of disease.

It follows that an unrestricted outbreak of disease in a mushroom house can be a million times more dangerous than a stray spore blown in by the wind. The stray spore is beyond our control, the patch of disease is not. Furthermore, it is the first patch that matters most. Too often we hear of growers who have disease on a large proportion of their beds but " cannot afford to sterilize the infected patches because they would lose so much of their crop." Extensive infection of this kind has very probably come from a local source of spores. We are assuming that the casing soil used is free from disease either naturally or as a result of sterilization.

The local source of infection may be a patch of diseased mushrooms on the beds, a growing colony, or an accumulation of the spores on some part of the building or bed supports. It may also be an infected site outside but near enough for spores to be carried into the house in large numbers.

The most important single step towards control of disease is to prevent the formation of any local source of spores. The second step is to reduce to a minimum the chance of spores being carried away from such a source. Any movement of spores is dangerous. Even if they do not get into the house they may start other colonies and so increase the risk of future infection. The third step is to organise the farm so as to minimise the chance of spores from an unknown source, or from one which is known but has not yet been destroyed, being carried into the house. We describe these precautions as applying to the growing houses. It is quite as important to apply them to the soil digging site, storage shed, and other buildings, and almost as much to the turning shed.

When a disease colony is found it is usually destroyed by heat or by fungicides. Some fairly recent discoveries have shown that there is no sharply defined temperature or strength of fungicide above which all

spores of one kind are killed, while below it they all survive. There is a very wide range of temperature which may be lethal, the proportion of spores killed increasing as the temperature rises, and unexpectedly high temperatures or long heating may be needed to kill the last few spores. The same principle applies to the strength of fungicides and time of exposure. These facts bring the numbers of spores into prominence. A sterilizing treatment regarded as normal may kill 999 out of 1,000 spores, and the one survivor may reasonably be considered fairly unimportant. But if the original number was 1 million, or 1,000 millions, there would be 1,000 or 1 million respectively, and neither of these could be ignored. In order to reduce their survivors to only one under experimentally controlled conditions, a higher temperature, a stronger fungicide, or a longer exposure would be needed.

There is no doubt that exposure to the full blast of a flame or to steam at boiling point, or thorough soaking with an effective fungicide is enough to kill all spores, whatever the original number. These treatments may fail, and undoubtedly do in some cases when applied to mushroom houses, because the condition of full exposure is not fulfilled. Some protection may also be given by other organic matter such as scraps of compost. All such material should be removed by thorough cleaning before sterilization. If only one spore in 1,000 survives in a crack in the timber, the number originally present may determine the severity of an outbreak of disease.

This shows the importance of reducing the number of spores released, as well as the number of colonies producing them, when any disease is present.

Although spores have no power of movement they are easily carried by the wind, insects, farm workers and their clothes and tools from places which might otherwise be considered harmless into mushroom houses and other buildings.

Spores may be taken up to a mile or more from a dump of spent compost by the wind or by flies. They can be brought out of cracks in timber or brickwork by any of the common mushroom pests or equally by other mites which are considered harmless because they do not damage spawn or mushrooms.

Workers may collect spores from a patch of disease on their hands, clothes and boots and carry them about, dropping a few on each bed and in each house as they work until the whole farm is infected, and the atmosphere of a mushroom house is usually favourable for germination. Then some growers say that a good synthetic compost will make mushroom growing easy !

Fortunately these things do not in practice all happen together, but they are quite common and nearly all of them are completely avoidable.

All workers emptying a house should sterilize their boots before going to a clean part of the farm. Boots and tools should always be sterilized before working on casing soil or in its storage shed.

If these measures are thoroughly carried out infection should only be possible through stray individual spores, against which there is no protection. The risk of germination can be reduced by keeping the temperature below 60° F. and by avoiding too high humidity.

The following list gives precautions which should be taken in each part of the farm and its work. The objects are to eliminate all sources of spores, to minimise the chance of carrying them, and to suppress disease at its first appearance.

We appreciate that to carry out **every** item in the list is a counsel of perfection and might involve re-building the farm, but we do recommend that all growers should make a serious effort to get as near to that ideal as they can. " How near can I get to it " is a much more profitable attitude than " I can't do that, so what's the use."

**Table of Preventive Measures against Mushroom Diseases.**

| | | |
|---|---|---|
| **1. TURNING SHED.** | | |
| (a) | Shed spacious. | Avoids condensation which encourages mould growth. |
| (b) | End nearest to mushroom houses walled off. | Reduces direct spore transfer by wind. |
| (c) | Floor of concrete to obviate dust, and sloped to drain off disinfectants and liquids from base of compost heaps. | Prevents mould growth. |
| (d) | All stale compost must be removed from shed. | Prevents mould growth. |
| (e) | Composting site must be disinfected after transfer of compost to houses. | Prevents mould growth. |
| **2. CASING-SOIL SHED.** | | |
| (a) | Closed in on all sides but provision for ventilation. | Keeps spores out. |
| (b) | Door on side remote from prevailing wind. | Reduces entry of wind-borne spores. |
| (c) | Floor of concrete. | Easily cleaned and kept clean. |
| (d) | Only casing soil stored here. | Reduces traffic. Excludes materials supporting mould growth. |
| (e) | Trough of disinfectant at entrance for workers boots. | Prevents spore entry on boots. |
| **3. MUSHROOM HOUSE.** | | |
| (a) | Entrance on side remote from prevailing wind. | Reduces entry of wind-borne spores. |
| (b) | Floor of concrete. | Easily cleaned and kept clean. |
| (c) | Adequate ventilation. | These conditions are unfavourable for germination of spores. |
| (d) | Temperature at or below 60° F. | |
| (e) | Relative humidity below 90% | |
| (f) | All woodwork impregnated with creosote. | Reduces mould growth. |
| (g) | Vessels containing disinfectant at ends and centre of house. | For tools, knives, etc. |
| (h) | Trough of disinfectant at entrance to house. | For boots. |

| | |
|---|---|
| (j) House fumigated with formalin before and after filling beds, before removal of spent compost, after removal of spent compost. | Kills spores exposed at each stage. |
| (k) Bed-boards dipped in disinfectant | Kills freshly deposited spores and mould mycelium. |
| (l) All vegetable debris and dead mushrooms removed from floor. | Removes food for mould growth. |
| (m) Spent compost removed by door and roadway not used for filling, picking, etc. | Avoids spreading spores where they are most likely to be picked up. |
| **4. PATHS.** | |
| Around mushroom houses paths should be covered with concrete and kept clean. | No sites for mould growth. |
| **5. STRAW.** | |
| (a) Mouldy straw should be rejected. | Damp, mouldy straw may support colonies of moulds which are mushroom bed invaders (viz.: *Chaetomium* spp. *Coprinus* spp. *Peziza vesiculosa*. *Aspergillus* spp. *Penicillium* spp. *Pellicularia*. *Trichoderma*). |
| (b) Straw must be sheltered from rain and dust. | |
| (c) If wetted before use for composting must be used quickly to avoid growth of low temperature moulds. | |
| **6. COMPOST.** | |
| (a) Observe standard methods of composting with regard to turning, humidity, temperature, aeration and reaction of manure. | Kills spores in manure. |
| (b) Bring to peak heat in house to chase insects to surface, and fumigate. | Kills pests which carry spores. |
| **7. CASING SOIL.** | |
| (a) To be taken at least 2 ft. below surface. | To avoid moulds which grow in surface soil. |
| (b) To be taken under cover of improvised shelter from winds. | To reduce contamination by wind-borne spores. |
| (c) To be covered while being transferred from pit to shed. | |
| (d) Casing-soil pit to be covered over when not being excavated. | |
| (e) If pit is flooded from surface it should be abandoned. | Flood water from surface carries down spores with it. |
| (f) Boarded approach to pit regularly treated with fungicide. | To prevent transfer of spores from surface of soil to pit. |
| (g) Entry to pit with gum boots. | |
| (h) Trough of disinfectant at entry to pit. | |

**8. EQUIPMENT.**

(a) Clothes.
Overalls and gum boots for all workers in mushroom house, worn in house only and kept in a clean room.

(b) Tools, spades, knives, barrows, etc., disinfected before and after use.

Minimise accumulation of spores on clothes and tools.

**9. DISEASED MUSHROOMS.**

Must be removed immediately, and before watering. Placed at site in vessel containing disinfectant. Site disinfected immediately. Mushrooms to be inspected daily.

Destroys source of spores.

**10. BED CONTAMINANTS.**

If known : killed at site of occurrence and removed with some casing soil in container. If unknown : sample removed in container for identification and remainder treated as above. Beds to be inspected daily.

Destroys source of spores.

**11. INSECTS AND OTHER PESTS.**

Control flies in house with D.D.T. Destroy maggoty mushrooms. Control mites, if possible.

Destroys carriers of spores.

**12. MUSHROOM STALKS AND DEAD MUSHROOMS.**

Do not store. Burn immediately.

Destroys food for mould growth.

# SELL YOUR SPENT COMPOST

**suggests E. T. ELLIS, F.R.H.S.**

*Editor, " Black's Gardening Dictionary."*

Many mushroom growers have large quantities of spent mushroom compost on their hands—hundreds of tons, I am informed—and do not realise that it is marketable. Normally it is regarded as a residue, unworthy of much consideration, whereas in reality it is most valuable " raw material." Nurserymen are willing buyers of old mushroom-bed manure ; why not advertise in the Trade papers read by them ? Quote it in 10, 20, 50 and 100 ton lots, carriage paid to any railway station in the United Kingdom. Do not quote by the truck, as trucks vary greatly in capacity. Offer it in two forms, screened and spade cut. Pare off and slice off the most loamy and highly decomposed surface and side few inches before selling, as these do not contain sufficient humus. It is not worth your while to bother about selling small quantities of the screened sort to nurserymen in sacks.

**Market Gardeners want it.** Market growers of vegetables, salad plants, tomatoes, etc., will buy large quantities of spent mushroom compost. It resembles old hot-bed manure in many respects, and few of

them can get anything like enough of that, as hot-bed gardening—styled French gardening—is not making the progress it might, owing to the shortage there is of fresh fermenting stable manure.

Market growers will buy the casing surface materials, if fully-decomposed, from the beds before they are broken up. This material should be offered at a cheap rate in ton or 20 ton lots.

Old mushroom-bed manure may be made into many excellent compost mixtures. A few recipes are given and many more might be mentioned if space permitted :

**Lawn dressing :** spent mushroom compost 10 parts, leaf mould 5, old soot $\frac{1}{2}$, bone meal $\frac{1}{10}$, mix well and put through a half-inch riddle before selling.

**Rhododendron top-dressing :** spent compost 10 parts, screened peat 5, leaf mould $2\frac{1}{2}$, year-old cow dung $2\frac{1}{2}$, see that no lime or chalky substance of any sort comes anywhere near. Sell to those with large collections of Rhododendrons and Azaleas.

**Greenhouse Potting Compost :** spent compost 5 parts, virgin loam 10, leaf mould $2\frac{1}{2}$, sharp silver sand $\frac{1}{2}$, wood ashes $\frac{1}{10}$, charcoal dust $\frac{1}{10}$. Sometimes bone dust might advantageously be added in the proportion of one-tenth part. Many greenhouse plants like spent mushroom compost as an ingredient of their potting soil.

**Flower-border manure :** spent compost 20 parts, spent hops (from breweries) 5, half-rotted tree leaves $2\frac{1}{2}$, fresh lawn mowings $2\frac{1}{2}$, liquid manure one soaking. The liquid manure is best prepared from one peck of fresh horse-droppings, a quarter peck of soot, and 30 gallons of soft water.

**Summer mulch :** The bigger mushroom growers should consider one or two summer mulches, which are in great demand in hot summers. Spent compost may be mixed with many materials. Examples are 10 parts spent compost to 5 parts lawn mowings, or 5 parts year-old cow manure, or $3\frac{1}{3}$ parts half-rotted farmyard manure. In all cases mix very thoroughly, and direct that a really good watering be given immediately before the application of the mulch.

# ITEMS OF GENERAL INTEREST

**The Fruit Grower.** The photograph of Dr. H. V. Taylor in our last Bulletin was reproduced from a block lent by the *Fruit Grower*. We regret the fact that this was not acknowledged at the time, all the more because the *Fruit Grower* has always been most helpful to the M.G.A. and most generous in the space it devotes to our activities.

**Samples of Compost.** Will members kindly refrain from sending samples of compost, pests, etc., to the Secretary. Whilst these are of great interest, the fact of the matter is that our headquarters are situated at a farm where they are extremely conscious of disease in any form. In fact we are becoming unpopular . . . . . Members should despatch to their nearest N.A.A.S. Officer.

**Exceptional Rates.** Growers sending regularly to markets can obtain special or exceptional rates from the railway company concerned. The method is to contact the Station Master of the nearest railway despatching point, who will go into the details and give the rates in individual cases. This amounts in some instances to a 25% reduction.

# The Worthing Growers and Research

Mr. Stanley Middlebrook, Chairman of the Mushroom Growers' Association, accompanied by Mr. F. C. Atkins and Dr. R. L. Edwards, Director of Research, Mushroom Research Association Ltd., were the speakers at the first meeting of the Winter Session organised by the Worthing and West Sussex Branch of the National Farmers' Union held at Worthing on the 19th January.

The meeting, which had a record attendance, heard Mr. Middlebrook state the case for the M.G.A. and how it had affected and would affect the individual grower. Mr. Middlebrook, who is one of the enthusiasts behind the formation of the M.G.A., travelled 600 miles to attend this meeting.

In his remarks on the need for research, Mr. Atkins said, " If research can help us, what problems do we most need investigating? I think we should get together on this question as soon as possible. We shall not get what we want unless we know what we are wanting!" Mr. Atkins then gave the following five points as what he personally wanted from the scientist :

1. Something more readily available, more reasonably priced, and less highly variable than the present horse manure we are getting.
2. I hope one day to know a little more about casing soils, apart from the disturbing fact that some soils are good and some are bad. (A pointer has been drawn by Pizer and Leaver, who discovered that a good soil on top of a bad soil crops well, while a bad soil on top of a good one crops poorly.)
3. I want work done on the control of disease by antibiotics.
4. I want research done on insecticides, so that when someone says that D.D.T. may be dangerous we don't all have to flee from it in case.
5. I want to know if growth-promoting substances have a part to play in our particular field.

## CONTRIBUTIONS OF SCIENCE TO MUSHROOM GROWING

Dr. Edwards, then gave a talk in the form of a reply to the points raised by Mr. Atkins. He said," Pure scientific research carried out for its own sake, or work done for other industries is sometimes applicable with very little modification to other purposes.

It is no discredit to the pioneers of pure culture spawn to say that its development was a direct application of the technique of handling pure cultures of all micro-organisms. The fundamental principles have been steadily developed since Pasteur demonstrated the existence of microscopic living organisms, and the same principles and techniques are used in medicine, industry and agriculture, wherever micro-organisms are handled. .

The other type of scientific research is that carried out from an early stage for our particular job. An example of this is Dr. Pizer's work leading to the use of gypsum. Pizer was studying a series of composts in which mushroom mycelium would not grow. He found that he could improve some of these composts by washing with suitable solvents. He related this improvement to certain colloidal materials

present, found that calcium salts which were known to affect colloids would improve greasy composts, and selected gypsum (calcium sulphate) as the most suitable because of its convenient solubility. None of that work would have been done for any purpose other than the growth of mushrooms.

Now let us consider Mr. Atkins s requirements from science:

1. Artificial composts are a special problem which must be separately investigated. Other work on agricultural composts leaves most of our problems unanswered. Synthetic composts have been made and used during recent years and considerable claims have been made in U.S.A., but I have not seen detailed figures for a really reliable comparison between artificial and horse manure composts.

There is no doubt that artificial composts can be made. I believe that 2 lbs./sq. ft. or more will be obtainable in skilled hands, but their preparation may well differ from that used for horse manure in various details and growers will have to learn the new technique. I do not expect to see a very much lower price than that paid for horse manure to-day. Straw, which is the most likely base material, is not particularly cheap.

A year ago I should have said that synthetic composts would probably be much less variable than those made from horse manure, simply because the proportions and quality of materials used are more closely controlled. Since then I have had reason to revise that opinion. We have found differences in yield from stacks of similar composition which are roughly as great as those commonly found between successive stacks made from horse manure. Some of these differences could only be attributed to quite small and unintended differences in the composting process, such as moisture, aeration and degree of packing. This is unsatisfactory from the point of view of experiments, and it will call for a continued application by growers of that skill which has been accumulated through the years and will now have to be adapted to new materials.

2. I have little to say about casing soil, although I hope we shall be able to tackle this problem later.

Pizer and Leaver's results on the effect of combining different soils are at present completely mystifying. Dr. Pizer told me that they have no explanation and only published their paper when it became clear that they would be unable to continue the work. When we know more about the function of casing soils I have no doubt that their work will provide a valuable link in the chain.

Dr. Bewley has done preliminary experiments with a very wide range of materials and I believe he intends to repeat some of the most promising on a larger scale.

I know of no fundamental work on the moisture and aeration controlling functions of casing soil, which I think will prove to be vitally important.

3. Antibiotics have been known as scientific curiosities for 20 years or more, although the name is of more recent origin. They came into prominence with the use of sulphonamides which probably depend for their action on the general principles of antibiotic action, and even more with the use of penicillin.

It was then a fairly obvious step to look for applications in other fields. Dr. Bewley has achieved some success in experiments with tomato fungus diseases, and I believe he regards that as a promising field.

We have tackled this problem in a small way at Yaxley and we have established that substances can be produced in cultures of moulds and bacteria which will suppress the growth of some of the principal mushroom diseases in pure culture, without stopping the growth of mushroom mycelium.

It is a long step from that to its application in practice. Many substances which are active in pure culture are not in the animal body or in soil, and I can only say that I do regard that as a distinct possibility for the future.

4. **Insecticides.** The advances in this subject during the last 10 years are comparable with those in antibiotics.

D.D.T., Gammexane, Velsicol and the ethyl phosphates, with others which are coming along, far outstrip the performance of the older insecticides.

Mushroom growing is the Cinderella of this picture, and the very speed of application in other directions exaggerates the waiting period while these things are studied and tried out to find exactly what each one will do to our particular pests, whether it is safe or what precautions must be taken in its use, and what is the best method of application. This is a field in which all the fundamental donkeywork is being done for us, and only relatively easy development work is needed to complete our picture.

It will be done. And I shall be very much surprised if any insect pest remains a serious problem 10 years from now.

5. **Growth substances and hormones.** It is about 20 years since the stimulating effect of a plant hormone on the growth of oat shoots was first observed. Since then many substances have been found to have a wide range of effects on plants, and highly specialized stages of development, such as setting or dropping of fruit and root formation can be artificially controlled by the right substance.

At the same time we have learned that many moulds and bacteria, and the mushroom is a mould, need one or more special growth substances in minute quantities for normal vegetative growth.

Treschow in Denmark found that some of these substances increased his yield of mushrooms.

We have done some preliminary tests on these substances at Yaxley and we have found significant effects—in one case the earlier appearance of the first pinheads and in another an increase in the number of mushrooms produced. I would venture to predict that in time we shall be able to assist the start of cropping, to raise or lower the number of mushrooms per sq. ft., and possibly to advance or retard the opening of the veil by means of hormone treatments.

I have forecast the answers to Mr. Atkin's demands. It will take many years of work for the limited number of scientists who are likely to work in this field to put those answers into practice and there is still much to be done on subjects which have hardly been mentioned to-day."

# "Six Tons of Mushrooms"

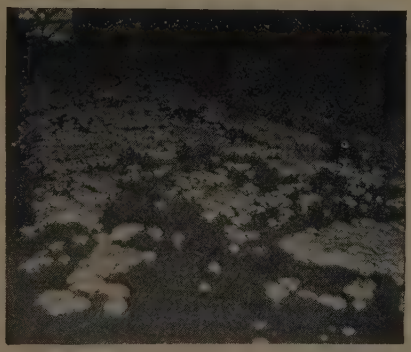

Illustration shows part view of a 250' Mushroom House, from which a total of six tons of mushrooms have been picked, belonging to Messrs. Church Farm Nurseries, Rustington, Sussex—an average of three pounds per square foot of mushrooms was marketed. The crop was grown entirely on Bushell's Long Straw Stable Manure

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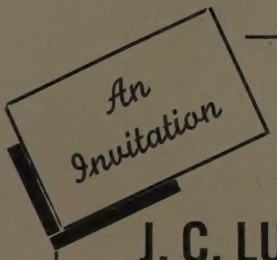


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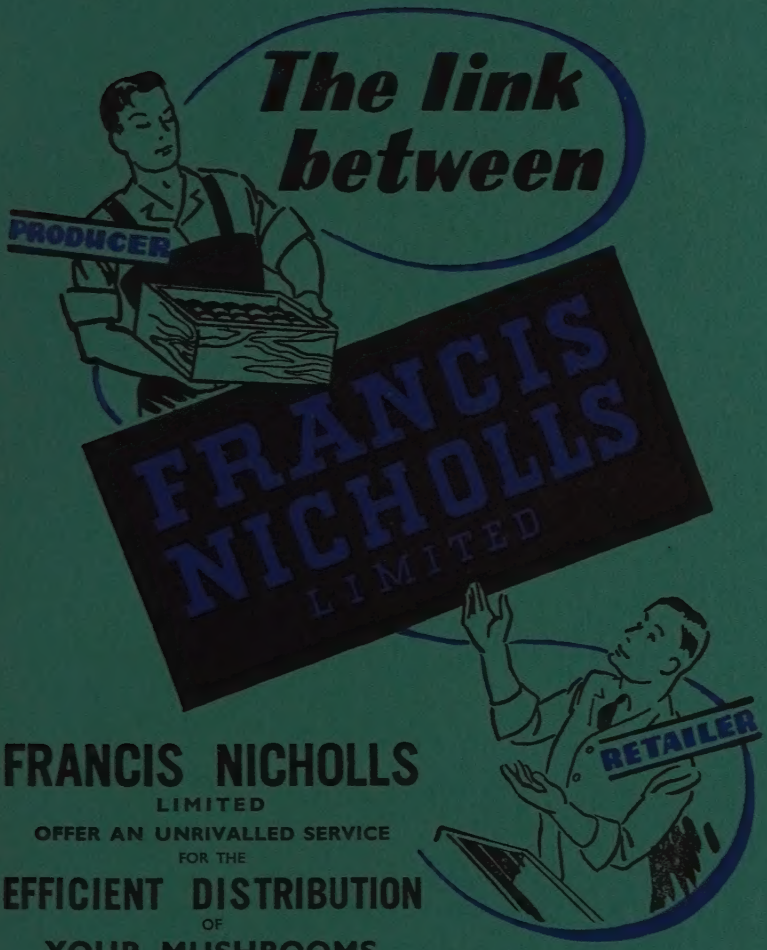


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